

## **REMARKS/ARGUMENTS**

### ***Election/Restrictions***

The provisional election of the claims of Group I (claims 1-8) with traverse is hereby affirmed. The restriction of to claims 1-8 for further examination is noted. In consequence, claims 9 to 20 have now been cancelled from this application without prejudice.

### ***Claim Rejections – 35 USC § 103***

The Examiner rejected the subject matter of claims 1 to 8 as unpatentable over admitted prior art in view of Bergeron (CA 2350814A1).

Bergeron relates to the production of  $\text{TiB}_2$  *in situ* in a carbonaceous material used for a cell lining. The material  $\text{TiB}_2$  is very expensive; the concept of Bergeron is to use less expensive starting materials ( $\text{TiO}_2$  and  $\text{B}_2\text{O}_3$ ) that react together in the conditions of cell use to form the more expensive material. By this means, a significant economy of costs can be achieved.

It is mentioned in Bergeron that a small amount of  $\text{TiB}_2$  (e.g. 3% to 10% by weight) may be added to the composition “to increase the kinetic of  $\text{TiB}_2$  formation during cell operation” (see page 11, lines 11-15). Since the objective of Bergeron is to avoid the use of  $\text{TiB}_2$  itself (because of its high cost), no more of this material would be used than is absolutely necessary to achieve the improved conversion of the precursors to the desired titanium diboride product. Therefore, there would be no likelihood of a person skilled in the art using more than the suggested amount of the  $\text{TiB}_2$  as a starting material in the aggregate composition (i.e. a person skilled in the art would not use more than the suggested 10% by weight).

The present invention, in contrast, is not concerned about achieving cost savings by using precursors of  $\text{TiB}_2$ , but rather it is concerned with a procedure for preventing the leaching of metal borides from carbonaceous cathode blocks and refractory coatings into the molten metal

produced in the cell. This is achieved by introducing an additive into a standard carbonaceous mixture including a large amount of  $\text{TiB}_2$ . The additive is a mixture of two components, one of which may be (among other things)  $\text{TiO}_2$  and the other of which may be (among other things)  $\text{B}_2\text{O}_3$ . During cell operation, these components react with molten aluminum within open pores present at the surface of the carbonaceous material to form  $\text{TiB}_2$  and  $\text{Al}_2\text{O}_3$  to achieve blocking or sealing of open pores in the surface of the material. This reduces the rate at which  $\text{TiB}_2$  particles leach out of the cathode material.

In the present invention, therefore, use is made of a major portion of  $\text{TiB}_2$  in the original aggregation and a minor amount of precursors. In contrast, in Bergeron, use is made of major amounts of precursors of  $\text{TiB}_2$  and a minor amount (or more usually no amount at all) of  $\text{TiB}_2$  itself. This is because Bergeron is (as indicated above) concerned with the minimization of the use of  $\text{TiB}_2$ , whereas the present invention is concerned with leaching of this material from a carbonaceous product when used in regular amounts. In the present invention, the amount of  $\text{TiB}_2$  provided in the carbonaceous material must be such that the surface of the material is wettable by the molten aluminium because, as stated on page 8, at lines 15 to 18:

*In operation, liquid aluminium wets the cathode and penetrates the cathode via open pores to depths ranging from 0.5 to 1 mm. During penetration, the aluminium reacts with  $\text{TiO}_2$ - $\text{B}_2\text{O}_3$  to form, at  $970^\circ\text{C}$ ,  $\text{TiB}_2$  and  $\text{Al}_2\text{O}_3$  ...*

It is the  $\text{TiB}_2$  that makes the carbonaceous material wettable and, if there is insufficient present, the surface will not be wettable and the molten aluminium will not penetrate the open pores at the surface and undergo the required reaction to seal the pores.

This concept is not discussed or alluded to in Bergeron and, as indicated above, a person skilled in the art, upon reading Bergeron, would not be motivated to increase the amount of  $\text{TiB}_2$  employed in the initial aggregate since the whole objective of this reference is to limit the amount of this expensive material. Rather, the skilled person would be motivated not to increase the amount of  $\text{TiB}_2$ . On the other hand, if a person skilled in the art were not concerned with the high cost of  $\text{TiB}_2$ , they would willingly use larger amounts and there would be no reason to rely

on the precursors of this material, so there would be no reason to add  $\text{TiO}_2$  and  $\text{B}_2\text{O}_3$  in the first place.

It is also clear that the amounts of  $\text{TiB}_2$  employed by Bergeron are insufficient to make the surface of the baked material wettable by molten aluminum because, as stated on page 10, lines 7 to 9:

*To produce a material having a wettable surface, a minimum concentration of about 30% by weight [metal boride] is required.*

The amounts of 3 to 10% by weight as used by Bergeron is therefore clearly not enough to produce a wettable material.

There is no reference in Bergeron either to the problem of leaching of  $\text{TiB}_2$  from the carbonaceous material during use, or to the possibility of using conversion products of the precursor materials to block pores or in any other way to protect the material from leaching out. There is therefore nothing in Bergeron that would lead a person skilled in the art to use a combination of ingredients as required by the present invention, i.e. sufficient  $\text{TiB}_2$  to make the surface wettable, as well as a mixture of the reactants that react in the presence of the molten aluminium to seal the pores. It is only after the pore-blocking ability of the reaction products is appreciated that the use of such a combination of starting materials appears to be desirable.

Bearing in mind that only 3 to 10% by weight of metal boride itself is added to the component in the cited reference, the component that is produced by the cited reference will not have a wettable surface at least until reaction within the cell has taken place. In contrast, the revised claims of the present application require the presence of sufficient boride to make the surface wettable before electrolysis commences. This ensures a better surface for the immediate wetting by aluminum and more effective penetration to take place.

It will be seen from the examples of the cited reference that the amounts of metal oxide employed in the mixtures is quite high (20%  $\text{TiO}_2$  and 30%  $\text{B}_2\text{O}_3$ ), but even so, it is not clear that wettable components are thereby produced by these examples. With such high (or perhaps even higher) amounts of oxides require to produce wettable components, the resulting composition

would not have particles of an oxide powder mixture positioned essentially in a carbon matrix between  $\text{TiB}_2$  particles as formed in the present invention (see passage bridging pages 7 and 8). It is these particles of the mixture that, in the present invention, react with penetrating aluminum to generate aluminum oxide that seals the pores and prevents leaching of metal boride. In contrast, in the cited reference, the use of a large amount of the oxide powder would produce a surface consisting predominantly of oxide powder and carbonaceous material that, upon reaction in a cell, would presumably create a surface consisting of metal boride, carbonaceous material and perhaps aluminum oxide without pores plugged by the aluminum oxide, thereby exposing metal boride to leaching.

While a small amount of  $\text{TiB}_2$  may be used as an optional ingredient in the mixture of the cited reference, it is employed only to speed up the kinetics of conversion of the precursor oxides (see page 11, line 11 of the cited reference). Moreover, for the conversion of the oxides to metal boride, the presence of aluminum may not even be required (see page 14, lines 21 and 22 of the cited reference) in contrast to the present invention.

To distinguish the present invention more clearly from Bergeron, claim 1 has been amended to require that the  $\text{TiB}_2$  is used in an amount sufficient to make the baked surface wettable by molten aluminium, so that the aluminium wets the baked surface, penetrates the pores therein, and reacts with the additive to form a dense phase at the surface of the cell component, the dense phase having low solubility in aluminium that seals the pores.

In short, on its own information, the components and mixtures of the cited reference do not have wettable surfaces (at least prior to reaction in a cell) because they contain only up to 10% by weight of metal boride, which is less than the 30% required for wettability. Not only is this a clear distinction, but also the resulting component would not have the same structure as that required for the present invention, i.e. the structure required to minimize leaching of metal boride into the cell contents.

Additionally, a new claim (claim 21) has been added that requires at least 40% by weight of  $\text{TiB}_2$  in the baked material. This figure is supported by the disclosure on page 8, at lines 6 and 7.

For the foregoing reasons, it is believed that this application is now in condition for allowance. Favorable action thereon is accordingly courteously requested.

Respectfully,

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I hereby certify that this paper is being deposited this date with the U.S. Postal Service as first class mail addressed to Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

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